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ABSTRACT

Traditional methods of job and task analysis may be categorized as worker-oriented methods focusing on general human behaviors performed by workers in jobs or as job-oriented methods focusing on the technologies involved in jobs. The ability of both types of traditional methods to identify, understand, and communicate the skills needed in high performance workplaces is being questioned with increasing frequency. Cognitive task analysis methods, which were developed in response to the perceived weaknesses of traditional job task analysis methods, focus on understanding and describing the cognitive components associated with task performance. Worker-oriented, job-oriented, and cognitive task analyses all have their own inherent strengths and weaknesses. Worker-oriented and job-oriented methods have yet to develop vocabularies relevant to workers' cognitive activities but have a long history of successful use. Cognitive task analysis, on the other hand, appears promising in its capacity to understand workers' cognitive activities but has yet to prove itself. Rather than deciding between the traditional and cognitive approaches, researchers should develop job/task analysis methods capitalizing on the strengths of both approaches. (Contains 39 references.) (MN)

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Traditional and Cognitive Job Analyses as Tools for Understanding the Skills Gap

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PREFACE

Is there really a skills gap? If so, how can the skills gap be understood? For decades, industrial psychologists have developed and used techniques for understanding workers' knowledge, skill, and ability needs. Have these techniques failed to identify a skills gap? Are new techniques needed?

This paper presents a conceptual model for thinking about how a skills gap may arise. With the model as context, it then reviews the methods of traditional industrial psychology and newer methods from cognitive psychology as they relate to understanding and reducing a skills gap.

This paper was written as part of a RAND research project "Skills Employers Want or Skills Employers Need: Skill and Attitude Requirements in the Workplace," conducted for the National Center for Research in Vocational Education (NCRVE), University of California, Berkeley. NCRVE is sponsored by the Office of Vocational and Adult Education, U.S. Department of Education.

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SUMMARY

Recently, much has been written and said about the school-to-work transition process. It has been the focus of such intense interest because employees find themselves struggling to succeed in the new high performance workplaces of the 90's. The difficulties they are experiencing are being laid at the feet of the education and training establishment.

Conceptually, the school-to-work transition process seems quite straightforward. Employers describe for schools and training organizations the skills needed by their employees, schools and training organizations impart these skills to students, who subsequently enter the manpower pool to be selected by employers.

Unfortunately, the process described above is only deceptively simple. The answers to several complex questions underlie the proper functioning of the school-to-work transition process. For example, what are the processes by which employers know the skills their employees need and by which they communicate those needs to the education and training establishment? This paper begins by describing a conceptual framework for examining the quality and kinds of information needed to support the school-to-work transition process. It ends with a review and comparison of the functions of traditional and more recently developed cognitive job and task analysis approaches for meeting the information needs of employers and the education and training establishment.

A vast amount of information is needed to support the school-to-work transition process, and this information can be seen to flow in a complete feedback loop. Jobs are structured as a constellation of tasks, some of which are part of the "official" job description and some of which are unique to the individual performing the job. Furthermore, jobs are not static through time. As requirements and/or equipment change, the skills that employees need to be successful may also change. Employers need to know the knowledge, skills, abilities, and personal

characteristics that are a requisite for successful job performance. That is, jobs and their requirements must be understood.

Once this information is known, it must be communicated to the education and training establishment in a way that they can use it effectively to prepare individuals for jobs. Next, as applicants make themselves available to employers, employers need to have methods for selecting those individuals that meet their entry-level job skill requirements. Finally, information needs to flow continually through this system to update the knowledge, skill, ability, and personal characteristic requirements of jobs as they evolve.

Job and task analysis have been the central components of these processes for decades, but recently some have begun to question the efficacy of traditional approaches. That is, it could be argued that one breakdown in the school-to-work transition process stems from the inability of traditional job and task analysis methods to help us identify, understand, and communicate the skills needed for success in the high performance workplace. As a consequence, new methods are needed.

Traditional methods can be categorized as worker-oriented or job-oriented. Worker-oriented methods focus on general human behaviors performed by workers in a job whereas job-oriented methods focus on the technologies involved in the job. In reality, these distinctions are often blurred. These methods have a long history of use and a substantial base of research that supports them. As machines have taken on more of the tasks previously performed by humans, the nature of work has changed. Demands on humans have increased and many tasks now call for inference, diagnosis, judgment, and decision making.

Cognitive task analysis methods were developed in response to the perceived weaknesses of traditional job and task analysis methods. These newer methods focus on understanding and describing the cognitive components associated with task performance. Black (undated) describes cognitive task analysis as a means for developing job descriptions "in terms of facts, procedures, images and mechanisms that workers would need to know to do the job, [with] descriptions [that] make reference to the appropriate knowledge representation forms."

Worker-oriented, job-oriented, and cognitive task analyses each have inherent strengths and weaknesses. Worker- and job-oriented methods have not yet even developed vocabularies that are relevant to a worker's cognitive activities, but have a long history of successful use. Cognitive task analysis is promising in its capacity to understand workers' cognitive activities, but has yet to be shown to be practicable in its application. Rather than abandoning either in favor of the other, researchers would do well to develop methods that capitalize on the strengths of each.

INTRODUCTION AND BACKGROUND

There has been no shortage of opinion about the existence of a gap between the preparation for work that students are receiving in our school systems and the preparation that employers say they need (Bailey, 1988; Carnevale & Gainer, 1989; Carnevale, Gainer, & Meltzer, 1989; Johnston & Packer, 1987; Noyelle, 1988; Raizen, 1989; Spenner, 1985; Stasz, Ramsey, Eden, DaVanzo, Farris, & Lewis, 1993; U.S. Congress Office of Technology Assessment, 1990; U.S. General Accounting Office, 1990). The challenges are for us to understand that gap and find ways to narrow it. The purpose of this paper is to discuss methods for improving our understanding of the skills gap.

Much has been written of late decrying the poor preparation of the U.S. workforce (cf., U.S. General Accounting Office, 1990). One of the roots of this problem, as noted in this report, is that "U.S. schools are generally isolated from the labor market and traditionally have not been responsible for assisting non-college-bound youth to make an effective transition from school to work (U.S. General Accounting Office, 1990, p. 27);" and there certainly seems to be overwhelming agreement that this is the nature of the skills gap.

We face two fundamentally different questions when we examine the postulated skills gap. First of all, we can speak of a skills gap for a specific employer (e.g., General Motors), or class of industry (e.g., manufacturing), or class of jobs (e.g., equipment maintenance technicians). In each of these cases there may be specific remedies for the specific problems that each employer, industry, or job class is experiencing. On the other hand, one can speak of a national skills gap that has broad effects across employers, industries, and jobs, and may require broader across-the-board solutions. For example, extensive illiteracy in the working age population would have serious consequences for most employers.

Unless we understand the nature of the skills gap, we may choose the wrong solution. If the skills gap is broad but firm-specific, then careful analyses need to be undertaken *in those sectors where there is a*

problem, and education and training need to be customized to those specific problems. If the skills gap is national, in the sense that all students are lacking a needed skill or set of skills (e.g., foundation skills), then we must examine a representative set of firms in order to draw appropriate generalizations about the nature of the skills that are lacking, and develop a broad education and training strategy that addresses those skill shortages. Reaching this level of understanding will require careful attention to, and analysis of those cases where employers identify skill-related problems in their workforce. That is, we must first understand *where* the problem exists. Once identified in terms of scope, there remains the question of specifying the nature of the skills gap and the remedy that is needed.

CONCEPTUAL MODEL

Figure 1 depicts a conceptual model of the flow of information that is associated with the successful transition of individuals from school or training to work. The critical information links that, if broken, would result in a skills gap are depicted in Figure 1. It is clear from the figure that these information links form a natural feedback loop. The skills gap may exist for several reasons. Traditional methods of determining, estimating, and understanding skill requirements may be failing (Figure 1, A). Educators may not have a clear understanding of the skills that workers need, perhaps because of a problem in communicating job skill requirements to them (Figure 1, B). Education and training institutions may not have succeeded in imparting those skills needed for the "high-performance workplace,"[1] (Figure 1, C). Or, the system of selecting workers from the applicant pool may be failing (Figure 1, D). This paper focuses on an examination of the methods available for determining jobs' skill requirements (Figure 1, A).

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[1]Characteristics of a high-performance workplace outlined by Labor Secretary Robert Reich (Vocational Training News, 1993) are: 1) greater reliance on workers for problem-solving; 2) a heavy emphasis on worker retraining to continually upgrade skills; 3) cooperation between labor and management; and 4) the integration of technology into the production process so that machines serve the worker rather than workers serving machines.

Traditionally, the theories and methods of personnel psychology have been designed and used to understand the behavior of organizations and individuals in organizations. Within the field of personnel psychology, research on personnel selection (i.e., matching people to jobs) and on training seems most relevant to understanding the skills gap. More specifically, this research includes the assessment of job requirements (i.e., what characteristics do employees need), applicant

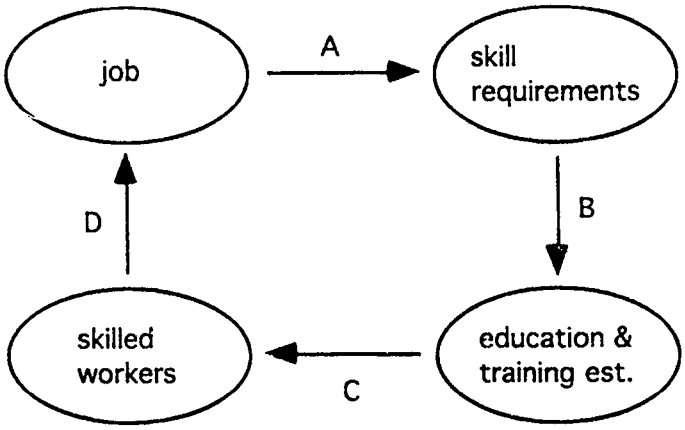

Figure 1—Critical Links for Providing Skilled Labor

characteristics (i.e., what characteristics do employees have), and the assessment of employee training needs and development of employee training programs to close that gap (cf., Goldstein & Associates, 1989).

The application of cognitive psychology to understanding job requirements is more recent (cf., Glaser, Lesgold, Lajoie, Eastman, Greenberg, Logan, et al., 1985). Methods based on cognitive psychology seek to "look inside the heads" of workers to determine the cognitive processes that occur during the performance of a job. They attempt to identify "the mental representations that people create for the goal structure of tasks and the rules they use to select specific knowledge and skills to apply to the task."[2] Assessing a job's task requirements

[2]Unpublished paper by John P. Campbell, *Alternative Job Analysis Models and Their Potential Application to a Revised Dictionary of Occupational Titles*, University of Minnesota, August 1992.

in this context forms the basis of cognitive methods for assessing job requirements.

This paper examines the approaches of both personnel psychology and the cognitive psychology to the problem of defining employee skill requirements.

UNDERSTANDING JOBS - THE BASICS

It is a mistake to think of jobs as clearly defined and immutable. Perhaps it is a strawman to even suggest that some think of jobs in this way at all. Nonetheless, when confronted with the problem of developing a system for educating and training people for jobs, we must first ask ourselves what it is we are training people to do. It is at this jumping-off point that we may be tempted to construct a definition of a job that may be characterized as unambiguous and unchanging, even though the job itself may be amorphous and fluid.

"Jobs" can be defined as "a set of task elements grouped together under one job title and designed to be performed by a single individual (Ilgen & Hollenbeck, 1991);" they are a cluster of official tasks assigned by the organization and labeled a "job."[3] However, as Ilgen and Hollenbeck (1991) state, "jobs exist in an environment that is *subjective, personal,* and *dynamic.*" The inherently individual nature of jobs gives rise to "emergent task elements" that result from the personalization of the job. That is, different individuals in the same job in the same organization may perform a slightly different set of tasks because of the way they and the organization, both formally and informally, have substituted tasks for, or added them to, the official set of tasks. We refer to these unofficial tasks as emergent tasks. Furthermore, the set of official job tasks may change over the course of time to encompass emergent tasks as the organization formalizes their performance into its official job definition.

The existence of emergent tasks in jobs presents a problem when we try to describe a job systematically. At the very least, it means that our definition of a job may differ dramatically depending on whom we ask

[3]Sometimes this is called a "position," and the set of tasks that an employee actually performs is called a "job."

to describe the job.[4] If we are going to develop a selection system or training program for a job, which tasks should be included? Should we select or train for only the "official" tasks? Obviously this is especially important if the emergent tasks require different knowledges, skills, abilities, and personal characteristics for successful performance than do official tasks.

Figure 2 characterizes two kinds of jobs in terms of their proportion of emergent tasks. Job A, on the left, consists of a majority of tasks that are officially defined--the employee performs few additional emergent tasks. Job B, on the other hand, includes a much greater proportion of emergent tasks. These differences could be inherent in the job; or they could be a function of the supervisor or employee; or they could result from some combination of all of these.

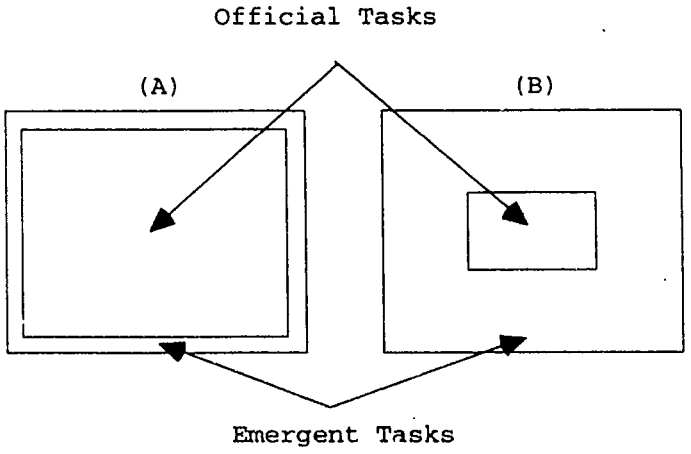

Figure 2--Examples of Jobs with Different Combinations of Official and Emergent Tasks[5]

[4]This isn't news to anyone. However, identifying the source of disagreement about jobs as arising from different sets of emergent tasks allows one to clarify usefully the definition of a job. For example, a training program could focus on both the "official" and not-yet-official but widely ascribed tasks, leaving uniquely emergent tasks aside. Similarly, by highlighting the distinction between official and emergent tasks in a job analysis, an organization may come to have a better understanding of its human resources and its human resource requirements.

[5]This figure is an adaptation of Figure 1 in Ilgen and Hollenbeck (1991).

This distinction between official and emergent tasks may be useful in helping us think about the broader picture of how jobs change and how education and training also must change (i.e., how we identify a skills gap and minimize it). For example, does a high proportion of emergent tasks in a given job signal a forthcoming redefinition of the job that in turn should signal needed changes in education or training? Are high-performance or flexible workplaces characterized by jobs that permit or even require the creation and performance of a greater proportion of emergent tasks (Job B, Figure 2)? Has the technology explosion lead to more jobs like "B" above?

Understanding job skill requirements calls for an organic perspective because jobs change as a function of time and the people who hold them. Formally distinguishing between official and emergent tasks in describing a job represents one example of how job analyses might be constructed to reflect the organic nature of jobs.

MATCHING PEOPLE TO JOBS - A BROAD OVERVIEW

This section summarizes the personnel selection process from the perspective of personnel psychology. In order to select employees from among job applicants, personnel psychologists have developed methods for analyzing jobs, for linking the results of job analysis to job skill requirements, for linking job skill requirements to required employee characteristics, and for assessing applicant characteristics (i.e., Figure 1, A and D). Some of these methods have been borrowed or adapted from other fields of psychology, such as from the study of individual differences, but many are quite specific to personnel psychology and the applicant selection process.

Figure 3 displays the general proposition. Jobs consist of (1) tasks (official and emergent) that are performed, (2) using a set of work aids, (3) under certain conditions. These variables form the grist of all job analyses. On the other side of the equation, people have certain knowledges ("a body of information applied directly to the performance of a function"[6]), skills ("a present, observable competence

[6]Uniform Guidelines on Employee Selection Procedures (1978). Federal Register, 43, 38290-38315.

to perform a learned psychomotor act"[7]), abilities (e.g., "cognitive ability"[8]), and other personal characteristics (e.g., "dominance, introversion, and leadership"[9]). Taken together, these individual attributes are referred to by the acronym KSAPC. Furthermore, these attributes may be learned (e.g., knowledges and skills) or enduring capacities (e.g., abilities and other personal characteristics), though some have argued this particular distinction.[10]

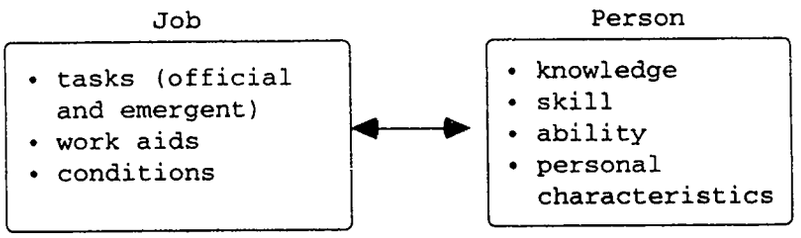

Figure 3—Person—Job Match

Matching persons with jobs requires that links be made between these two kinds of information, i.e., we seek to minimize the (skill) gap between a given applicant's capabilities and a given job's requirements. There are two inferences that must be drawn or established that may not be immediately apparent in Figure 3. First, a

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[7]Uniform Guidelines on Employee Selection Procedures (1978).

[8]Harvey (1991, page 76).

[9]Harvey (1991, page 76).

[10]Complicating the selection process even more, employers may elect to specify, or the structure of a job may dictate, those specific characteristics that an applicant must have prior to being employed versus those characteristics that will be taught or may be learned after employment. This, of course, raises the whole issue of who should be responsible for developing the "human capital" of individual workers. If employers require that workers have a specific set of characteristics prior to employment, either applicants themselves, former employers, or society-at-large must bear the burden of instilling those characteristics in individuals. Clearly, employers try to make these decisions to their benefit. For example, employers are more likely to provide firm-specific training than generic job-skill training. Though employers may choose to provide extensive training, it is usually not provided to those who have the largest skill gaps (Lillard & Tan, 1986). For purposes of this paper, however, it's enough to focus on what that training should be without going into who should be responsible for providing it.

detailed description of the job in terms of tasks, work aids, and conditions is not the same as, and does not necessarily lead directly to a specification of the knowledges, skills, etc., that are required to perform them. For example, consider the following task description:

> Asks questions; listens to responses of complainant, clarifying vague emotionally charged statements about complaint; and records information on form questionnaire in order to specify source, nature, and scope of the complaint. (Fine & Wiley, 1971, page 46).

Although this is a detailed description of a task, it does not directly specify the characteristics a successful performer would need. This is generally true of task descriptions, even though in some cases required knowledges *may* be more easily discerned than required skills, abilities, or other personal characteristics. Similarly, another inference that must be made is that the selection instrument(s) (e.g., tests, interviews, transcripts) reflect the KSAPCs identified as required for the job. That is, if knowledge of electrical principles is required for the job, does the selection process provide a measure of the applicants' knowledge of electrical principles? Thus, a person-job matching system consists of a series of inferences and/or empirical linkages that must be made between the definition of a job and the characteristics of those individuals that are chosen to be employed.

The techniques that are used to draw the inference between a job description and the KSAPCs required for successful performance are largely judgment-based. Typically, job supervisors or other subject matter experts identify the KSAPCs that are required to perform the tasks, and then judge the "relative importance" of the KSAPCs to job success (Harvey, 1991). Unfortunately, once these judgments are made, only indirect methods (e.g., inter-rater reliability) are available to assess their accuracy. After the KSAPCs required for the job have been identified, more empirical methods, such as construct validity, are available to decide whether the selection instruments actually measure those characteristics in applicants (i.e., to assess the validity of the selection instruments as measures of the identified KSAPCs).

Ultimately, this system of inferences and empirical links is embodied in a set of selection procedures for a job or jobs. The validity of the system itself is then open to empirical examination, and it is the historical extent of these validities and their utility for selecting employees that buttress the inferences underlying the construction of such systems (cf., Boudreau, 1991).

ASSESSING JOB REQUIREMENTS

A multitude of methods have been developed for analyzing and describing jobs (cf., Fleishman, 1982). These methods fall under the general rubric of job analysis. What follows is a brief description of several job analysis methods.

TRADITIONAL METHODS FROM INDUSTRIAL PSYCHOLOGY

To begin, it is important to note the pivotal nature of job analysis in the practice of industrial psychology. Job analyses generally serve several purposes (Harvey, 1991): 1) the development of job descriptions; 2) the development of performance appraisal systems, including appraisal instruments and performance standards; 3) the development of employee selection systems, including instruments and standards; 4) the development of compensation systems; and 5) the development of employee training programs (Goldstein & Associates, 1989; McCormick, 1976; Ostroff & Ford, 1989).

Job analysis seeks to include a complete description of all tasks performed as part of a job. Thus, the distinction between official and emergent tasks is irrelevant to job analysis methods because these methods analyze *extant* jobs. That is, current job analysis methods are static like still cameras rather than dynamic like video cameras--the result is more a snapshot of a job than an organic image of a job. A thorough job analysis will include a description of both official and emergent tasks, but not necessarily how those tasks have developed across time, nor how different individuals have personalized them. It is designed to capture all the relevant information available at the time of the analysis that is needed for the person-job match system described above.

However, even if the information to expand the analysis in the direction of an organic image of the job is available, it typically is not done because the goal of traditional job analyses is to find commonality across descriptions of a job--variability within a job that comes from emergent tasks may be relegated, conceptually, to the error

term. So, for example, if each member of a secretarial pool evinces very few emergent tasks, the final secretarial job description may not include any of the emergent tasks. If, on the other hand, each member of the pool performed a large proportion of different emergent tasks, a traditional job analysis would most likely indicate that the jobs in the pool were not the same.

Tasks can be described either in terms of the steps they entail or in terms of the attributes needed by a successful performer. Traditional job analysis methods can be broadly categorized as worker-oriented, or job-oriented (some refer to these as task-oriented).[11] Worker-oriented methodologies have been designed to be broadly applicable to a wide range of jobs across a number of organizations. These focus on general human behaviors that workers perform on the job in contrast to job-oriented methods that focus on the technologies involved in the job. The distinction, however, is more one of degree than of kind (Harvey, 1991).

The most well known of the worker-oriented instruments is the Position Analysis Questionnaire (PAQ; McCormick, Jeanneret, & Mecham, 1972). The PAQ consists of 189 job elements subdivided into six major categories of worker activities: information input (i.e., where does the information come from?), mediation processes (i.e., what does the worker do with the information), work output (i.e., how does the worker actually perform the work), interpersonal activities, work situation and job context, and miscellaneous aspects (e.g., schedule, responsibility).

Job-oriented methods are more typically embodied as task inventories. These methods are highly specific, usually consisting of a list of hundreds of distinct tasks, and constructed specifically for each job or family of jobs to which they will be applied. Each task is typically rated by incumbents and/or supervisors on the dimensions of frequency, difficulty, and importance of its performance to the job at

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[11] In an unpublished paper, John P. Campbell suggests that another categorization might be to think of job analysis techniques as describing individual characteristics that range from math aptitude and perceptual speed (i.e., characteristics that are relatively stable individual differences) to a description of expert-level performance on a particular job.

hand. This method of job analysis has been used for decades by the U.S. military services as a basis for job classification schemes and training development (Christal, 1974; Morsh, 1964). An example of a highly structured method of task analysis is Functional Job Analysis (FJA; Fine & Wiley, 1971). FJA requires that task statements consist of a detailed description of an action, the observable results of the action, work aids used in the task, and the extent to which the worker has discretion in choosing how to perform the task.

Of the two broad categories of job analysis techniques, job-oriented methods historically are more often used for the development of training (cf., McCormick, 1976). Does the continued existence of a skills gap indicate a failing in these traditional methods? Even if these methods acquire the appropriate information needed for preparing individuals for jobs, there is still the potential for the system to breakdown at other points (refer to Figure 1).

However, there may be other shortcomings of traditional methods that limit their continued applicability. As Howell and Cooke (1989) point out, it is somewhat paradoxical that as intelligent machines have taken over tasks that in the past were performed by humans, the demands on humans have increased rather than been reduced. "What were once highly structured tasks may now call for inference, diagnosis, judgment, and decision making (Howell & Cooke, 1989 p. 123)." Perhaps work is becoming increasingly less observable because more of it takes place within the heads of workers. To the extent that past methods of job analysis do not even have a language that is capable of expressing the cognitive tasks that workers must now perform, they will be incapable of providing the base of knowledge required to assess and communicate skill and ability requirements.

COGNITIVE TASK ANALYSIS

The basis of the cognitive task analysis approach is to attempt to understand and describe the cognitive components associated with task performance. The form of knowledge representations involved in the performance of tasks is an important aspect that cognitive task analysis seeks to identify, often by examining the differences between experts

and novices in terms of the structure and use of their knowledge. Black (undated) describes cognitive task analysis as a means for developing job descriptions "in terms of facts, procedures, images and mechanisms that workers would need to know to do the job, [with] descriptions [that] make reference to the appropriate knowledge representation forms." For example, a clerical worker may need to know how to cut and paste text using a word processor; an expert may understand how it works (e.g., have a mental model of cut and paste buffers), and a novice may know how to do it without understanding how it works. Whereas a traditional job analysis would identify the task and perhaps even the skills needed to perform it (e.g., keyboard familiarity, ability to use specific wordprocessing software, etc.), a cognitive task analysis would identify the task and the knowledge representations associated with performing the task as a novice and as an expert (e.g., procedural vs. pixel imagery). A practical example of the application of cognitive task analysis can be found in the work of Means and her colleagues (Means et al., 1989).

Cognitive task analysis (CTA) employs several methods; among the most common are observation and interviewing. Observation techniques used in CTA do not differ substantially from those used in traditional job analysis. They provide limited information, usually centered around a simple identification of the tasks that are being performed and the conditions under which they are performed.

According to Cooke (undated), interviews are the most commonly used technique. However, "the results of these techniques are often unwieldy and difficult to interpret (p. 8)." Some problems with interviews can be alleviated by using a structured approach. Because traditional job analyses also often use interviews, distinguishing between traditional and CTA approaches becomes a question of the structure around which the interview is constructed.

Campbell[12] lists three CTA methods that could all be considered variants of a structured interview. The first of these is to have an expert observe and critique the performance of a novice. In this case,

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[12]ibid.

the performance of the novice provides the structure for the interview. The second is to have experts arrange the steps of a task in order of performance and then ask them to explain why they chose that order. The third is to present a case problem to experts and to ask probing questions while they think through it. These methods might be categorized as "process tracing" using Cooke's taxonomy. One of the problems with such process tracing methods is that experts may have automatized their behavior such that they are unable to vocalize the process they are following.

In addition to process tracing, Cooke (undated) describes two other sets of methods, structural and decision analysis techniques. These methods have quite specific uses, in contrast to those mentioned above. The purpose of structural techniques is to produce a representation of an expert's task knowledge, and decision analysis aims to understand the decision making process associated with a task.

With regard to its handling of emergent tasks, cognitive task analysis would not likely differ from traditional job analyses. While cognitive task analysis seeks to provide a different approach to understanding and describing the skills needed to perform a job, it still must begin with and manage job descriptive information in terms of what tasks are performed and by whom.

ASSESSING APPLICANT CHARACTERISTICS

Assessing job requirements using one of the methods described above completes only half of the skills gap equation. The other half of the equation relates to the characteristics of the labor pool. What are the capabilities that applicants or workers have, and are applicants or workers lacking in the capabilities that are needed for successful job performance? To the extent that there is a difference between the capabilities required for successful job performance and the capabilities of members of the labor pool, a skills gap exists. Because this paper focuses on the definition of job requirements as they relate to the skills gap, I only briefly touch on the assessment of applicant characteristics.

The assessment of applicant characteristics has been widely studied and published in the industrial psychology literature (Guion, 1991; Guion & Gibson, 1988; Landy & Shankster, 1994; Schmidt & Ones, 1992). In this literature, individuals' characteristics are often defined in terms of cognitive (i.e., general and specific mental abilities), physical (i.e., body strength, agility, etc.), and personal attributes (i.e., personality and life experiences). Techniques for assessing these characteristics include paper and pencil tests, interviews, assessment centers, and work samples or simulations. Given the rather ubiquitous finding that general cognitive ability predicts performance in most jobs, there has been little attention in recent years in this literature to developing measures of specific abilities (Schmidt & Ones, 1992).

Guion (1988) noted a movement in cognitive psychology that had as yet unfulfilled potential for shaping the assessment of cognitive abilities in employment testing. Whereas traditional assessments of cognitive ability have focused on general mental abilities, cognitive psychology has begun to focus on defining and measuring specific cognitive abilities such as visuo-spatial and verbo-sequential skills (cf., Gordon & Leighty, 1988; Ronning, Glover, Conoley, & Witt, 1987). However, as Guion stated "No new employment tests have emerged from such studies..."

ASSESSING EDUCATION AND/OR TRAINING REQUIREMENTS- WHERE DO WE GO FROM HERE?

It would seem that a natural outgrowth of the work in job analysis would be to inform the debate about the school-to-work transition process (Raizen, 1989; Stasz, et al., 1993; U.S. Congress, 1990). For example, it would seem that clear statements about the knowledges, skills, abilities, and personal characteristics required to be a successful performer would be useful to organizations that provide training (e.g., secondary and postsecondary institutions, occupational training centers). Furthermore, industrial psychology has long struggled with translating job requirements (KSAPCs) into instruments that assess the extent to which individuals possess them. Unfortunately, a quick perusal of the industrial psychology, cognitive psychology, and school-to-work transition literatures shows them to be neither well cross-fertilized nor well cross-referenced (cf., *Journal of Applied Psychology, Personnel Psychology, Educational Researcher, Cognitive Science, Review of Educational Research*). They are like the proverbial ships passing in the night.

The methods we have presented above are used to determine the skills needed for successful job performance and to assess the skills that individuals possess. Conceptually, the skills gap is simply the difference between these two. Are the traditional job analysis methods used by industrial psychologists failing to adequately identify or communicate the skills needed by successful workers and does cognitive task analysis provide a solution? (That is, links A and B in Figure 1, repeated below).

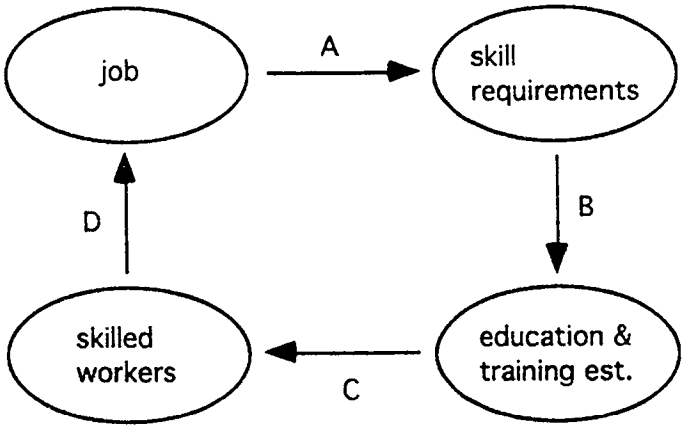

Figure 1—Critical Links for Providing Skilled Labor

In comparing traditional and cognitive job analysis methods, Glaser and his colleagues (1991) suggest that a selection strategy developed using traditional job analysis methods

> "might be very effective at picking the right people to be taught a job without being particularly good at specifying how those people...will differ in either their ability to learn or their post-training performance... A major purpose for cognitive analyses is to...identify the kinds of skills and knowledge that must be acquired in school and on-the-job experience, that are basic to the development of job competence."

Campbell[13] notes that while some of the aims of traditional and cognitive task analysis methods differ, "one purpose that is shared in common is the determination of specific training needs relative to some set of people and jobs (p. 22)." Thus, the distinction between traditional and cognitive methods is not whether one method determines specific training needs and the other does not, but rather how well. Howell and Cooke (1989) claim that although structured job analysis techniques include cognitive elements, they are at a level that "fails to capture the underlying structure of human cognition (p. 148)." This implies that knowing the underlying structure of human cognition as it relates to performance on a specific task will be useful in training people to perform that task. Howell and Cooke assert that although

[13]ibid.

traditional methods may identify what is to be learned, they are lacking in identifying how it may be learned best.

Because so little applied field work using cognitive task analysis methods has been published, at the present time it is difficult to judge its potential benefit over the more traditional methods from industrial psychology. Nonetheless, cognitive psychology brings with it a very different way of thinking about these problems, and it is intriguing to consider its potential effect over time. For example, tests of general ability have long been shown to be valid for predicting job performance, yet there is some debate as to whether these validities are stable over time. Some hypothesize that validity declines over time because cognitive resources, indexed by scores on general ability tests, become less important as skills develop (cf., Lord and Maher, 1991). This kind of fresh insight into the issues surrounding workforce training, job analysis, and personnel selection must necessarily yield a benefit.

Perhaps neither traditional job analysis nor cognitive task analysis, alone, is adequate to the task of providing the information necessary for erasing a skills gap. In the long run, it will be better to consider the potential for synergy between them. As more and more of work begins to take place outside the range of traditional methods of observation, innovative methods need to be developed to understand it, and these methods need to be adapted from laboratory use--too long the primary realm of cognitive scientists--to field use. That is, we need to begin to see more widespread application of cognitive task analysis methods in use in workplaces so that the costs and benefits to be derived from these methods can be determined. At the same time, long known lessons from industrial psychology, including recent research reestablishing the role of personality and motivation as relevant to successful performance (e.g., Hogan, 1991) must not be forgotten. Researchers interested in exploring the skills gap would do well to attend to what both cognitive science and industrial psychology have to offer.

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